Investigation for Poster Reading Habit of Researchers with Different Academic Background

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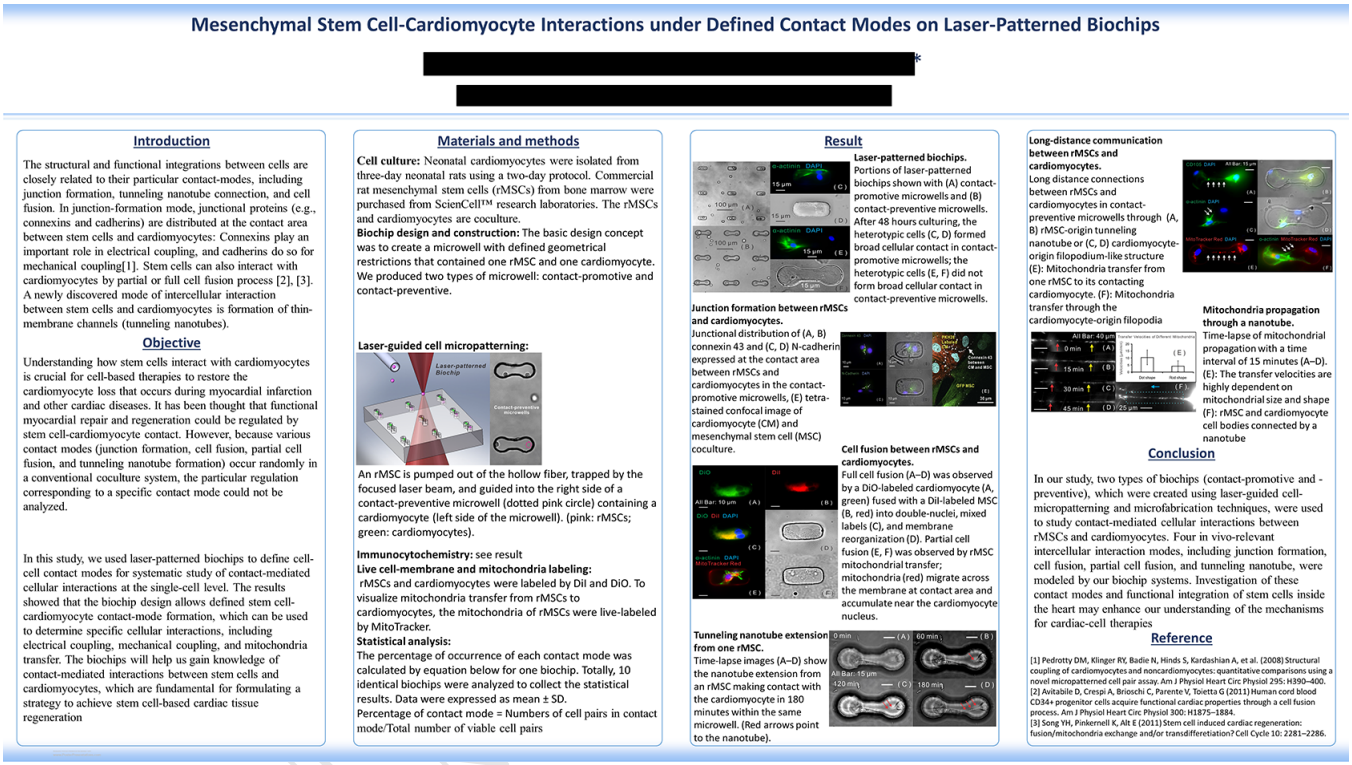

Figure 1: A example of designed poster

ABSTRACT

The emergence of a large number of scientific papers calls for a short version of scientific papers to convey researchers' ideas, especially for these interdisciplinary studies. Posters appear in various fields as a new format to efficiently and coherently express core ideas of original papers. Interestingly, although poster has been used in a large number of different fields, the compositions and layout for most posters in various areas are similar. However, there is little to no-depth knowledge about the different reading habits of readers with diverse backgrounds to read academic posters with similar compositions and layout. In this paper, we explore the preference in poster reading of researchers with different academic backgrounds via studying researchers' poster reading habits collected with eye-tracking methodology.

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Conference'17, July 2017, Washington, DC, USA

ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in visualization**; *Empirical studies in interaction design.*

KEYWORDS

eye-tracking, poster reading, reading behavior, education

ACM Reference Format:
Aileen Wei and Zongming Yang. 2019. Investigation for Poster Reading Habit of Researchers with Different Academic Background. In *Proceedings of ACM Conference (Conference'17).* ACM, New York, NY, USA, 13 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

Recently, eye trackers are extensively used to investigate the pattern of human cognition in different fields[1], including education[2], medical[3], user interface interaction[4], marketing[5], and media[6]. Education is one of the significant areas where the understanding of the human cognition pattern is needed. Familiarization of your peer's work is an essential aspect of education. Though reading academic papers is the most common way to know your peer's work, it is also a time-consuming task for most researchers, especially for researchers who work for interdisciplinary studies. The emergence of a large number of scientific papers calls for a short version of scientific papers to convey researchers' ideas. Posters appear as a new format to efficiently and coherently express core ideas of original papers in many different fields. Interestingly, although poster has been used in a large number of different fields, the compositions and layout for most posters in various areas are similar. However, there is little to no-depth knowledge about the different reading preference of readers with diverse backgrounds to read academic posters with similar compositions and layout. What do researchers choose from a poster? Which items and areas of the poster do they attend to and which of these do they actually read? Are reading paths for all researchers the same? In order to figure out the answers of these questions, we start this study.

In this study, eye-tracking is used for collecting reading path and gaze to analyze the poster reading pattern from participants. We explore the cognitive pattern in poster reading of researchers with different academic backgrounds (computer science and biology) via studying researchers' poster reading habits. The goal is to correlate poster reading pattern with understanding rate of computer science researchers and of biological researchers when they read computer science and biological posters.

First, we provided four posters (one entry-level computer science study, one entry-level biological study, one hard-level computer science study and one hard-level biological study) for 10 computer science researchers and 10 biological researchers to read with eye-tracker. In the second step, we asked them to answer some questions based on the posters and choose the important parts for understanding each poster. Professional researchers evaluate their understanding of the posters based on their answers for each poster. Finally, we discuss the poster reading pattern and correlate their poster reading pattern with understanding rate.

Our hypotheses is biological researchers are more focusing on methodology, results and conclusion. Instead, computer science researchers pay more attention on introduction, objective and methodology. This study can contribute to advance the poster marking for these interdisciplinary studies to effectively convey the core ideas of academic papers to researchers with different academic backgrounds.

2 BACKGROUND

2.1 Poster advantages and poster making

Though reading academic papers is the most common way to know your peer's work, it is also a time-consuming task for most researchers. The emergence of a large number of scientific papers calls for a short version of scientific papers to convey researchers' ideas, especially for these interdisciplinary studies. Posters appear in various fields as a new format to efficiently and coherently express core ideas of original papers, usually during conferences. Posters allowed the conference participants to have a 'snapshot' of the findings[7]. Posters also allowed researchers' results to be presented in a commutable environment, which will enable participants to exchange ideas[8]. Compared with oral presentation held at a particular time, poster presentation is more flexible in the time. Since posters tend to stay on display throughout a conference for a whole day for the most circumstance[9]. Lots of literature have been discussed on how to create a qualified scientific poster. Qiang and coworkers used machine learning to study the practical layout of the posters through training on the readable posters[10]. Several requirements should be achieved in poster making in order to generate a qualified academic poster:

1) Both important textual and graphical contents need to be extracted correctly.
2) Both textual content and graphical elements (table, images) need to be fit each panel and optimized for readability.

Recently, poster template emerged as an easier way to generate scientific posters to share the researchers' ideas effectively. One main reason for the emergence of these templates is the popularity of posters used in a large number of different fields.

2.2 Eyetracking and poster

Eyetracking has been extensively used in studying different aspects of reading, including font size and type[11], similarity-based interference[12], sentence comprehension[13]. Besides, eye tracking has been used to study reading habits and recognition patterns in different media, including newspaper[14], web-page[15], etc. Though these media may share some commons with poster, there are not many eye tracking studies analyzing the recognition pattern for poster reading.

Hao and coworkers, in 2019, for the first time, used eye tracking technology to assess the cognitive pattern for poster reading[16]. In their study, they concluded that the gaze entropy and mutual information from individual gaze information channel are related to participants' individual differences. From our perspective, their emphasis on individual difference may incorrect since they didn't categorized the participant in their study.

3 METHODOLOGY

In this paper, eye-tracking is used for collecting the preference of poster reading pattern from participants. We explore the cognitive pattern in poster reading of researchers with different academic backgrounds via studying researchers' poster reading habits. One plain poster layout is used as the template (Fig. 1) to generate posters(http://www.academicposter.org/postertemplates.html).

Besides, to study the relationship of participants' poster reading

behavior and understanding rate on entry-level and hard-level reading materials, one entry-level poster and one hard-level poster are used in the study for each field, respectively. Graduate students from computer science and biology will be asked to read both posters containing contents of computer science and biology.

3.1 Apparatus and site setting

The Gazepoint GP3 eye tracker (Gazepoint) is corneal reflection eye tracker detected with infrared light. Its controller (Gazepoint controller) was utilized for data collection and data analysis. The participants looked at the high resolution (1680×1050) 24 inch monitor that displayed the 4 posters. The experiment was conducted in a quiet and dark room. The sampling rate of Gazepoint is 60 Hz. The accuracy of eye tracker is 0.5-1 degree.

3.2 Poster making and stimulus

We made four posters based on four academic papers as shown in Fig. 2.

One is a well known entry-level biological field paper(Fig. 2A). It showed that election stimulation caused the vagus nerve to secrete chemicals that decrease heart contractions. The author of this study was awarded Nobel prize in 1936 because of his discovery about the role of acetylcholine as an endogenous neurotransmitter. The other biological paper is a hard-level paper(Fig. 2B). It showed that mesenchymal stem cell-cardiomyocyte interactions under two defined contact modes on laser-patterned biochips. It is a cutting-edge paper published in 2013 with complex experimental design and cutting-edge technology.

For the two computer science papers, one is an entry-level paper about quick sort(Fig. 2C). Quick sort is a very popular data sorting algorithm that has been developed[17] since 1960s. It is a divide and conquer algorithm which creates two empty arrays to hold elements less than the pivot value and elements greater than the pivot value, and then recursively sort the sub arrays. There are two basic operations in the quick sort algorithm, swapping items in place and partitioning a section of the array. The other one is a hard-level computer science paper(Fig. 2D) talking about image reconstruction based on sparse 3d point cloud[18], which is published in the top conference of Computer Vision and Pattern Recognition(CVPR). It shows that point cloud and the associated attributes like color and SIFT descriptors contain enough information to reconstruct detailed comprehensible images of the scene which will lead to potential privacy problems.

Four papers are selected as testing materials to set up the experiment. Posters are made based on papers. All students participating in the experiment had an efficient reading ability to understand the tested posters and confirmed that they had never seen the materials before. Moreover, we defaced the author and institutional information.

3.3 Subjects

A total of 20 graduate researcher students (10 from computer science and 10 from biology or bioengineering) from Clemson University participated in the eye-tracking experiment. Each student read four posters. Their ages range from 22 to 30 years. All the participants have the ability to understand English and have normal color vision. In addition, they have never seen the 4 posters before. All participants received consent form at the beginning of the experiment. They filled in a pre-questionnaire about their basic information and a post-questionnaire about four posters.

3.4 Experimental design

10 computer science graduate research students and 10 biological graduate research student read 4 different posters(mentioned in poster making and stimulus section). Within-subject effect would be a measure of absolute and percentage time for each individual's time spending on different posters in our experiment. Between-subject effect would be a measure of absolute and percentage time for different individual's time spent on each poster. It is a 2 X 4 study(2 Groups with 4 different posters).

3.5 Procedure and data collection

All participants received a consent form and a pre-questionnaire at the beginning of the experiment. Equipment calibration was conducted before the formal experiments. Then, the participants were instructed to view the posters as they read the paper-version posters as usual. The posters were presented one after another. These tested materials were presented for three minutes or stop for next when readers pressed their space key. Everyone was seated in a chair, and asked to lean forward to rest his/her chin comfortably, with his/her head 60 cm distant from the computer screen. During eye-tracking, no interaction occurred between the operator and the participants. After the experiment, each participant was asked to fill a short post-survey questionnaire. Eye movements were recorded with a Gazepoint GP3 eye-tracking system. The raw video data was produced by its software. The video data was input to the eye-tracking analysis software to edit AOIs, creating some visualizations (scan path, heatmap of AOIs) and a series of fixations (the start time, the duration, and the X and Y positions on the screen). The following analysis is based on this format of eye-tracking data.

3.6 Statistics

The statistics analysis is implemented with python. In total, 2 different test groups (BIO and CS) were investigated. For each test group, 10 samples were tested. Before merging data from different samples in the same test group, Levene's test was used to ensure the equal variance assumption. For comparing differences among groups with normally distributed and equal variance, the two way ANOVA test was used. P-values of less than 0.05 were considered significant. Usually the two way ANOVA will show the significance of two factor's main effect as well as their interaction. Based on the two way ANOVA test, we analyzed the reading pattern among different group and the relationship between group and posters or area of interests.

4 RESULTS

4.1 Scan path

Data on visual behaviour can be used as measures of attentional processes. The actual paths of visual behaviour across the poster can be seen as the scan paths (Fig. 3), which are shown from the whole time of reading and scanning the poster. The circles indicate fixations, i.e.

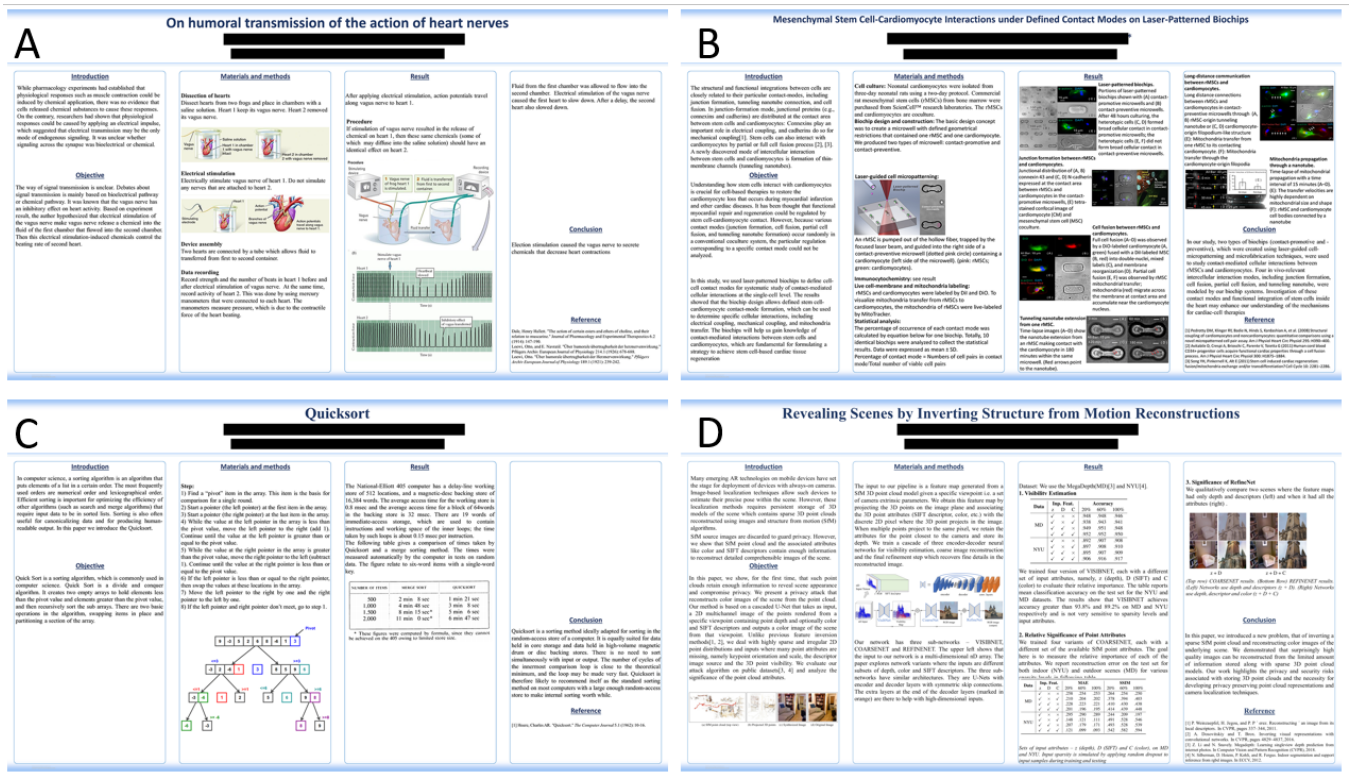


Figure 2: The layout and content of four posters. A is entry-level biological poster; B is a hard-level biological poster; C is entry-level computer science poster; D is hard-level computer science poster.

pauses when the eye rests for intake of information. Larger circles indicate longer fixations. There is a 1-second filled reference circle in the bottom left corner. Lines indicate saccades, which are quick jumps (20–50 milliseconds), when the reader changed the position of the eye to reach the next landing position.

Fig. 3 shows Scan paths and fixation of all 8 cases. A, C, E, G is typical examples of biological students read poster 1, 2, 3, 4, accordingly. B, D, F, H is typical examples of computer science students read poster 1, 2, 3, 4, accordingly. We may notice that for BIO group, the main concentration is located in the middle and right of the poster which is related to paper method, result and conclusion. However, for CS group, more attention will be paid to the left part of each poster which is related to paper introduction, objectives and method. This observation slightly shows there might be existing difference in reading pattern between BIO group and CS group based on poster content(area of interests).

To further analyze reading paths and reading priorities, each poster has been segmented into 7 areas: Title, Introduction, Objective, Materials and method, Result, Conclusion and Reference (Fig. 4).

For each subject, we mapped the time sequence order in which these defined areas caught the attention of the reader. The order sequence was treated as a score (1 = 7 points, 2 = 6 points, etc.). Scores for each area were then added across the all biological and computer science readers (see Table 1). The time sequence order of attention is shown in Figure 5 of reading.

From table 1, we can see that the total scores of CS group on paper Introduction and Objective are always higher than that of BIO group. Whereas, the total score of BIO group on paper Result and Conclusion are always higher than that of CS group. These observations give us a strong hint that CS group and BIO group may have difference in reading pattern considering poster content. CS group will pay more attention to Introduction and Objective while BIO group will pay more attention to Result and Conclusion.

The time sequence order of attention shown in Fig. 5 also displayed the different reading orders between BIO group and CS group considering poster AOI. From the scan path and time sequence order of attention, we noted biological students do not read in the ordinary sense. Besides title, many biological students chose to read materials and method section first, then introduction-objectives-result-conclusion. Computer science students read from title to introduction and gradually towards result.

To further analyze the fixation, we shown the heat-map of all computer science and biological students on poster 1, 2, 3 and 4 (Fig. 6). From the fixation, we see students from computer science and biology have remarkable different patterns during reading. Biological students focus more on method, result and conclusion. Computer science students are more focusing on introduction, objective and materials and methods.

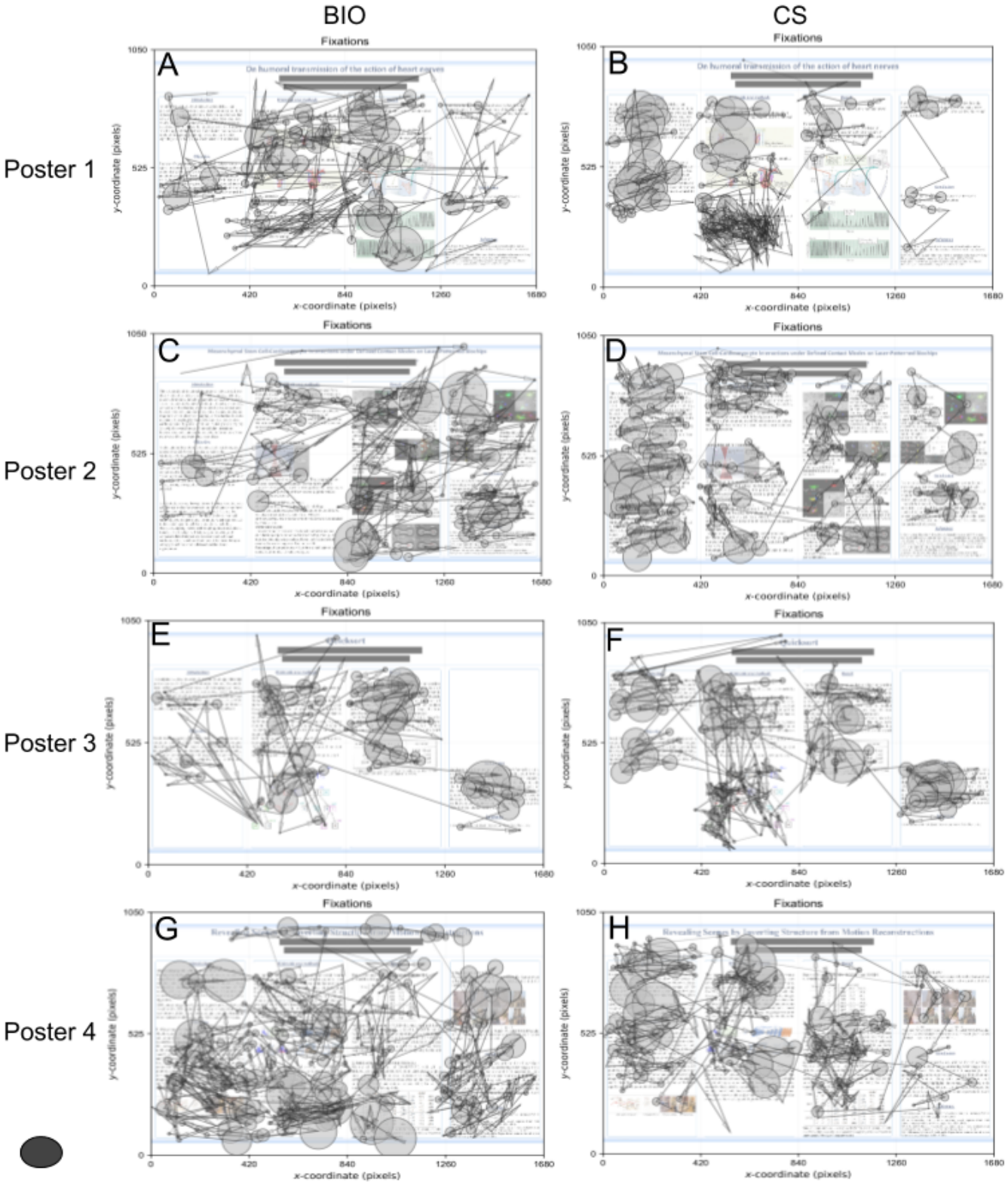


Figure 3: Scan paths and fixation of all 8 cases. A, C, E, G is typical examples of biological students read poster 1, 2, 3, 4, accordingly. B, D, F, H is typical examples of computer science students read poster 1, 2, 3, 4, accordingly.

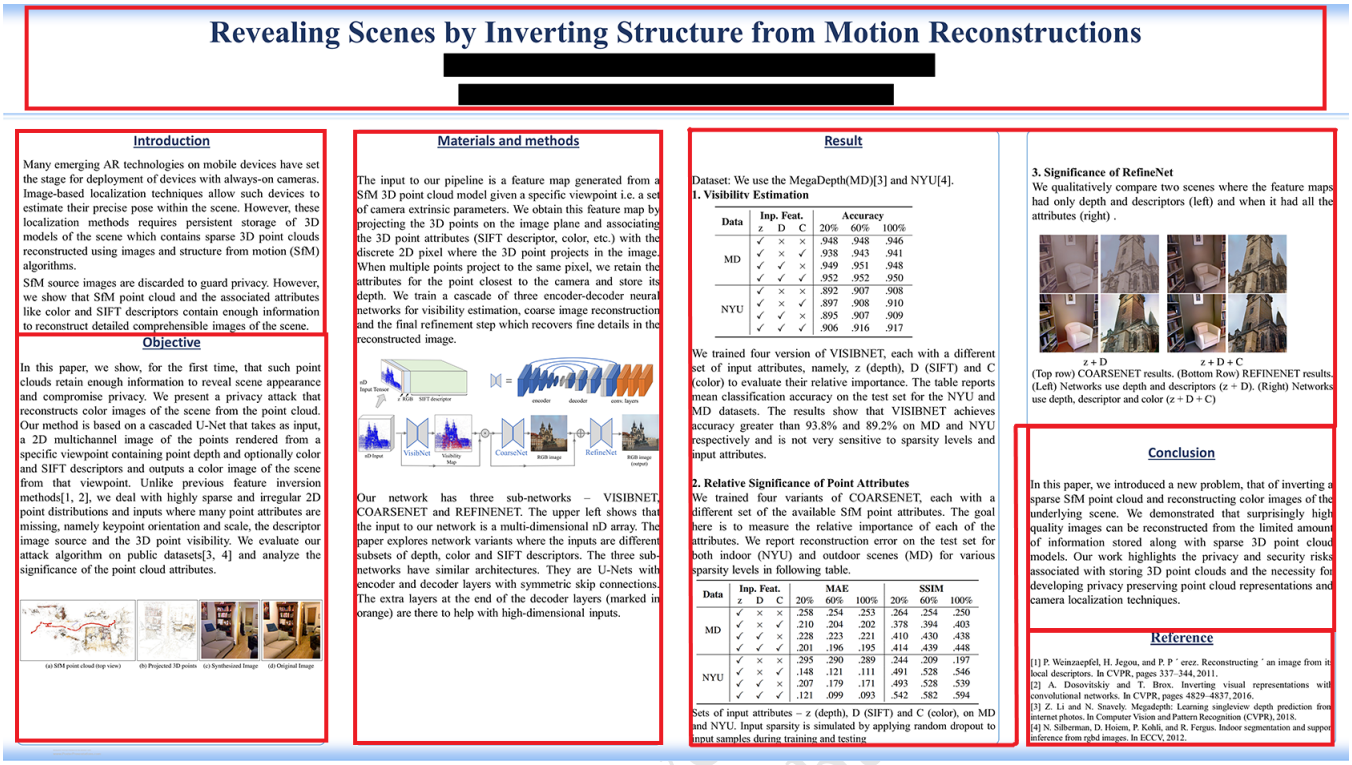


Figure 4: An example of poster segmentation

Table 1: The score of the order sequence

Sum of Score		Area of Interests						
		Title	Introduction	Objective	Materials&method	Result	Conclusion	Reference
Poster 1	CS	54	65	55	43	31	12	8
	BIO	43	53	44	56	41	21	9
Poster 2	CS	69	59	49	39	22	6	1
	BIO	59	46	44	46	41	20	7
Poster 3	CS	42	67	51	44	29	17	3
	BIO	31	67	49	47	37	24	9
Poster 4	CS	64	62	52	41	24	11	0
	BIO	67	61	51	34	31	13	1

4.2 Average absolute and percentage time

Then we analyze allocated time for different sections in the poster by reader. For each reader, we recorded the absolute time spend on each section and then calculated the time spent on each segment of the poster as a percentage of the entire time spent on the poster.

4.2.1 Average absolute time. We first use two way ANOVA to analyze the significance of group factor and poster factor as well as their interaction. In Fig. 7A, it shows the average absolute time spent on each poster(mean + standard deviation) based on different student group(BIO/CS). We compared the absolute time for biological and computer science students on poster 1, 2, 3, 4. The result shows that there is no difference between two test groups (BIO and CS). The Fig. 7B shows the two factor ANOVA analysis, from which we can know that none of the simple group factor, simple poster factor or group-poster interaction is significant. This means based on average absolute time, the two factor group and poster have no significant effect and no significant interaction.

4.2.2 Average percentage time. Now we analyze the percentage time for each segment for biological and computer science students on poster 1, 2, 3, 4. The results in Fig. 8 show that different groups spare different time on each poster AOI. The BIO group would spare more time on paper Method and Results while the CS group would spare more time on paper Introduction, Objective and Method.
For further analysis, we did the two way ANOVA for each poster considering group factor and AOI factor in Fig. 9. For poster 1, the average time percentage on each poster AOI is shown in Fig. 9A.

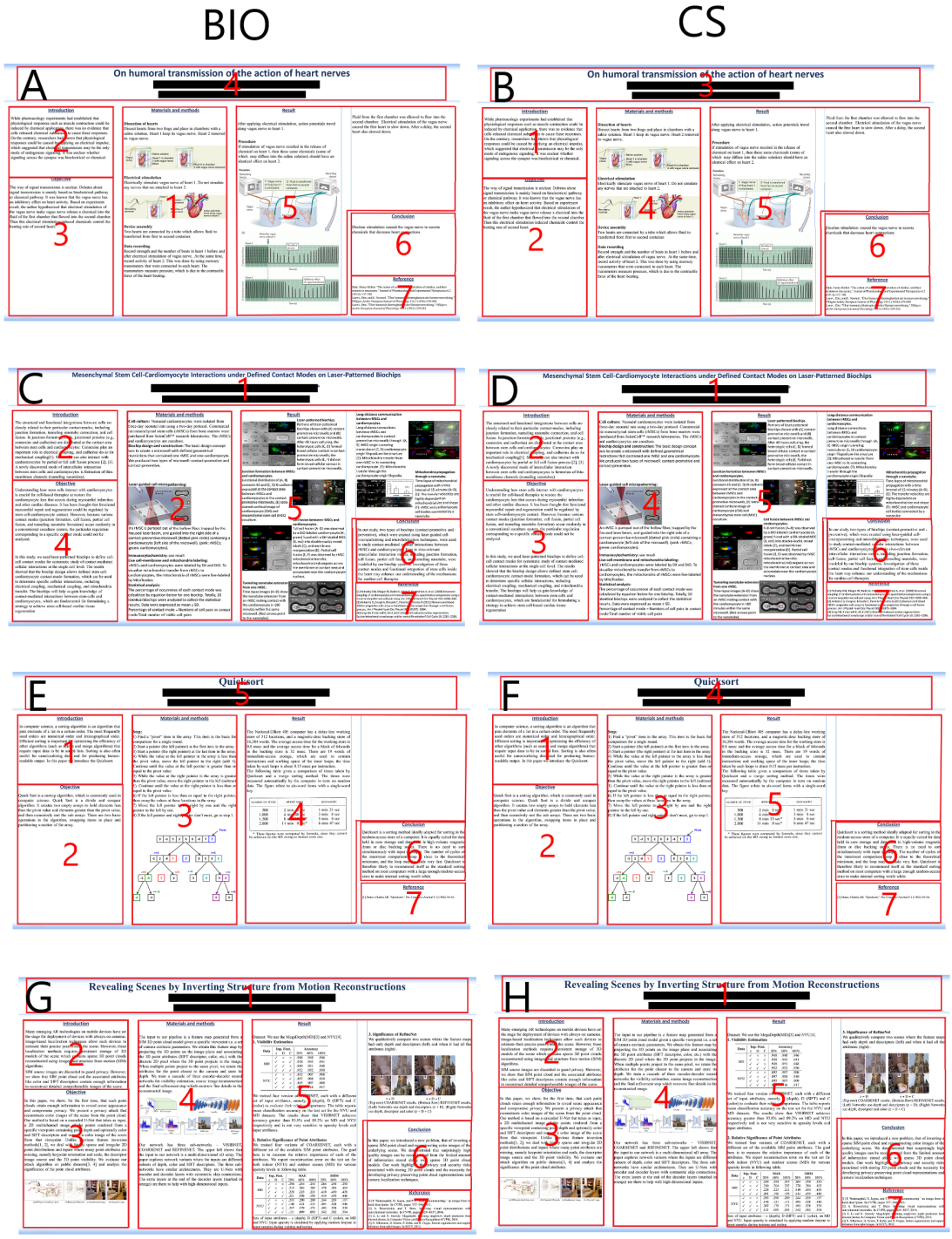


Figure 5: Time sequence order of attention. A, C, E, G is time sequence order of attention of biological students read poster 1, 2, 3, 4, accordingly. B, D, F, H is time sequence order of attention of computer science students read poster 1, 2, 3, 4, accordingly.

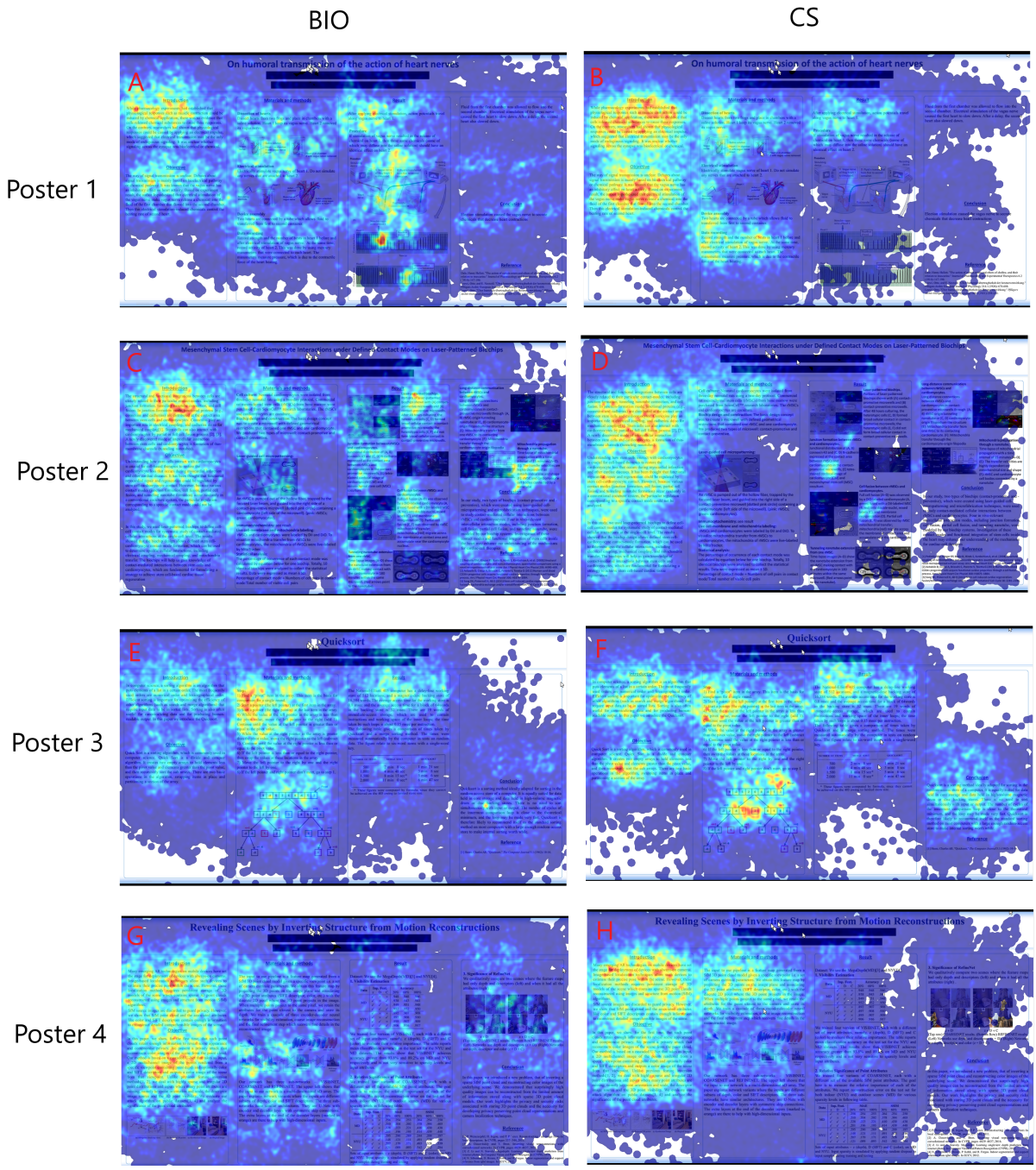
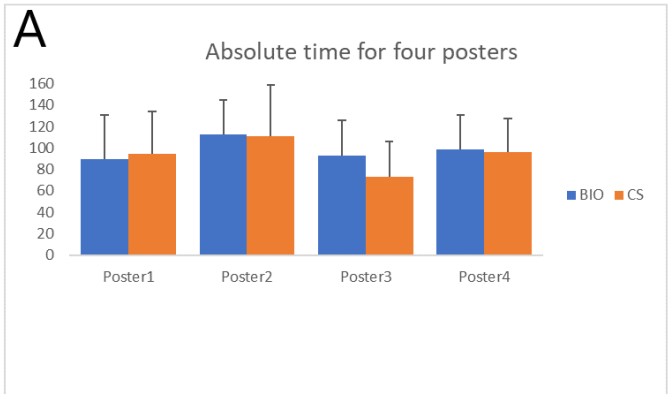


Figure 6: Heat-map of reading time. A, C, E, G is head-map of biological students reading poster 1, 2, 3, 4, accordingly. B, D, F, H is heat-map of computer science students reading poster 1, 2, 3, 4, accordingly.

From Fig. 9B the analysis of two way ANOVA, we can see that AOI factor is significant as well as the group-AOI interaction. So we can know that AOI keeps main effect on time percentage during poster reading, and each group shows different AOI reading habits since the interaction of group factor and AOI factor is significant. The similar analysis could be conducted on poster 2, 3, 4 in Fig. 9D, F, H. And we could see that AOI factor is significant over all 4 posters with the group-AOI interaction showing important effect. So we may conclude that different reading group may show different reading habits based on poster AOI.



B

Two-way ANOVA for four posters

	Source	SS	DF	MS	F	p-unc	np2
0	group	388.876	1.0	388.876	0.246	0.621832	0.004
1	poster	8036.099	3.0	2678.700	1.693	0.178003	0.078
2	group * poster	1394.298	3.0	464.766	0.294	0.829706	0.014
3	Residual	94910.266	60.0	1581.838	NaN	NaN	NaN

Figure 7: The average absolute time spent on different posters.

4.3 Understanding rate

In the last part, we show our statistic result for understand rate (Fig. 10A). For two biological posters, no one in computer science understood the content. Instead, 80 percent of biological students understood the content of entry-level biological poster. 50 percent of biological students understood the content of hard-level biological poster. For entry-level poster in computer science, 50 percent biological student and 100 percent computer science student truly understood the content of that poster. For hard-level poster in computer science, 10 percent biological student and 30 percent computer science student understood the content of that poster. Fig. 10 B to E show the statistics about answer to which parts are most important for understanding contents. We can notice the same pattern as shown in fixation heat-map. Biological students thought method, result and conclusion can help to understand the content, while computer science students thought introduction, objective and method are more important for understanding the content of poster.

5 DISCUSSION / CONCLUSIONS

From the scan path and time sequence order of attention, we noted biological students do not read in the ordinary sense. Besides title, many biological students chose to read materials and method section first, then introduction-objectives-result-conclusion. Computer science students read from title to introduction and gradually toward result. From the fixation heat-map, we see students from computer science and biology have remarkable different patterns during reading. Biological students more focus on method, result and conclusion. Computer science students are more focus on introduction, objective and materials and methods.

Our observation is consistent with our hypothesis that biological researchers are more focusing on methodology, results and conclusion. Instead, computer science researchers pay more attention on introduction, objective and methodology. Our statistics based on two-way ANOVA confirmed our observation that different groups show different reading habits considering poster AOI. The interaction of group factor and AOI factor occupies an important part in poster reading.

Our questionnaire about important parts for understanding content also confirmed our observation. Biological students thought method, result and conclusion can help to understand the content, while computer science students thought introduction, objective and method are more important for understanding the content of poster.

These results can explain the low understanding rate of computer science students for entry-level biological poster. When biological students prepare their poster, they put emphasis on method, result and conclusion. However, computer science students ignore these important parts in biological poster because they thought introduction and objective will tell them the whole story when they read a poster. For hard-level poster, both test groups put more efforts on the the parts which they thought are more important. For biological students, they paid more attention on method. Instead, for computer science students, they care more about objectives. Thus, for both test groups, though they can get the important parts from the poster in their own academic background, they may ignore important information when they read poster from other academic background. This study can contribute to advance the poster making for these interdisciplinary studies to effectively convey the core ideas of academic papers to researchers in biology and computer science. Since both test groups pay more attention on method, we can merge all important information in materials and methods section when we make poster for biological-computer science interdisciplinary studies.

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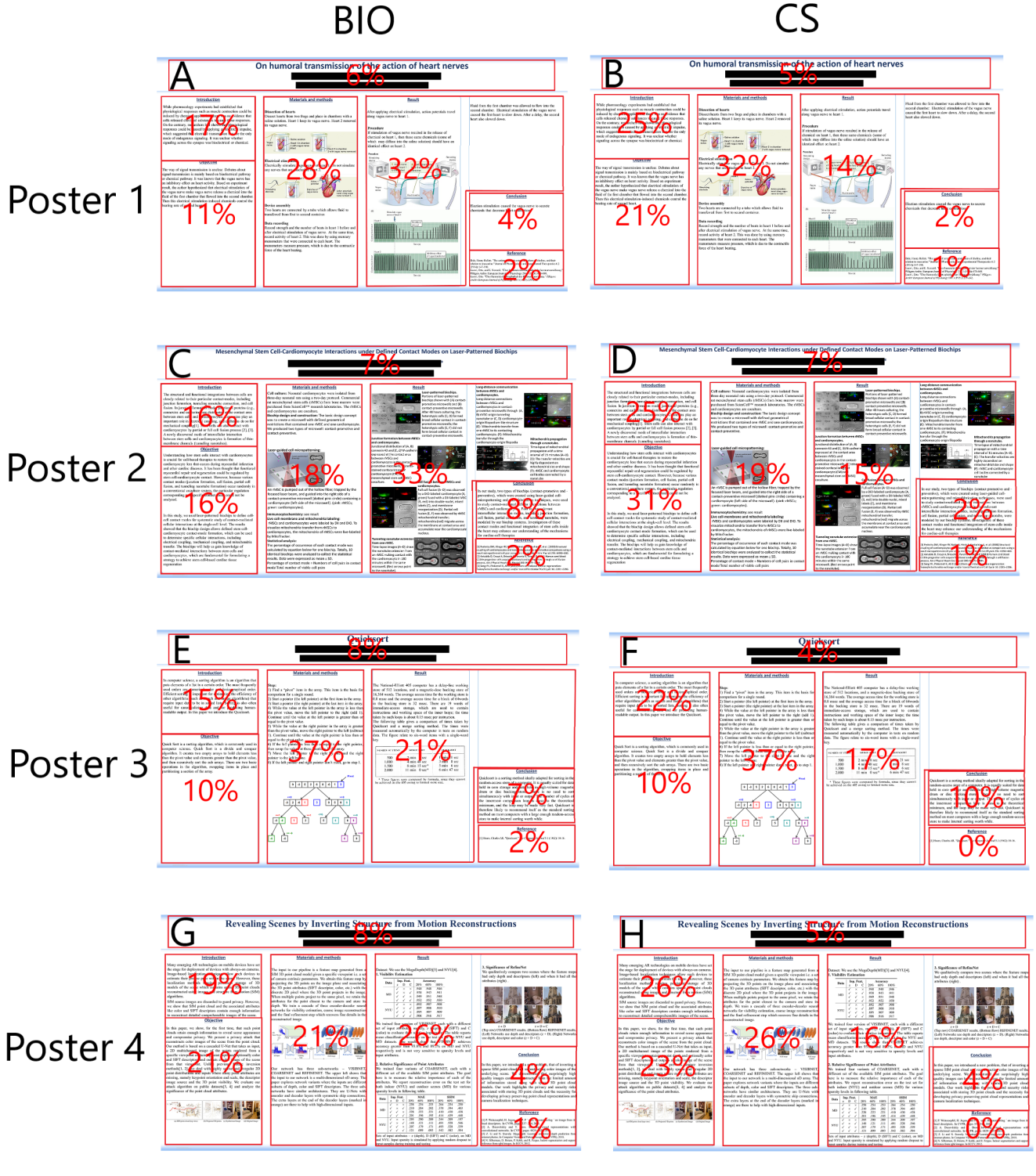
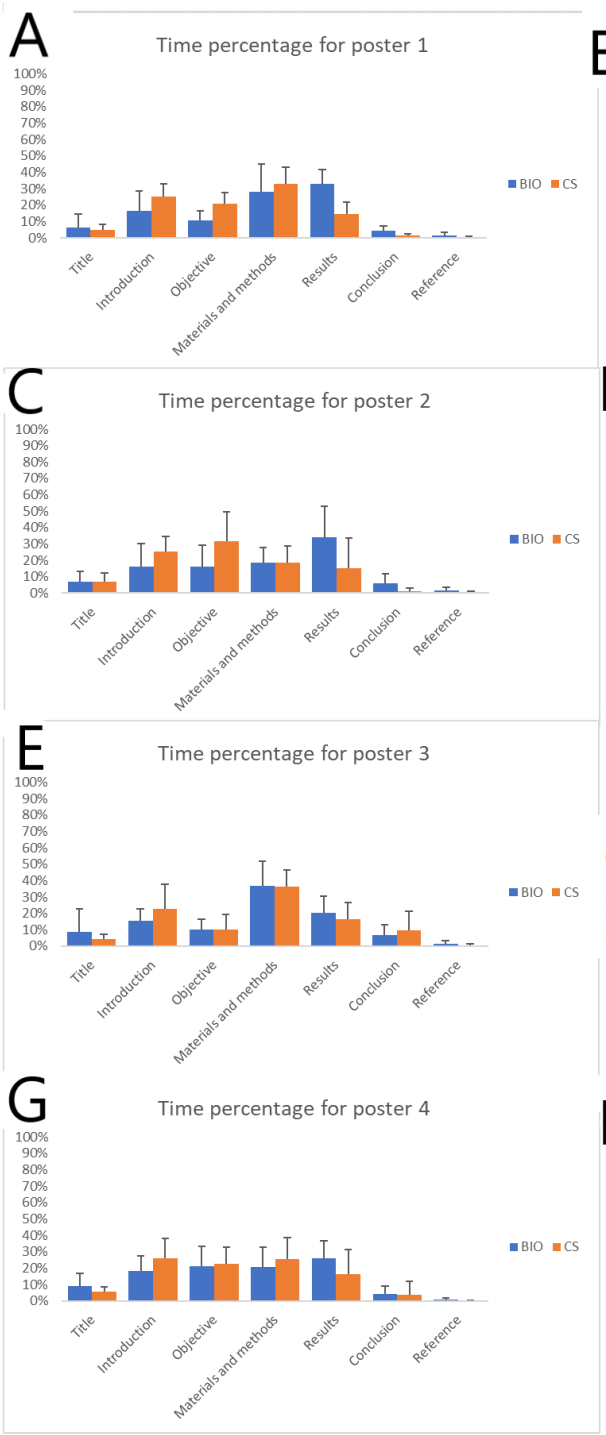


Figure 8: The average percentage time spent on different segments. A, C, E, G is the average percentage time spent on different segments of biological students read poster 1, 2, 3, 4, accordingly. B, D, F, H is the average percentage time spent on different segments of computer science students read poster 1, 2, 3, 4, accordingly.



B Two-way ANOVA for time percentage for poster1

	Source	SS	DF	MS	F	p-unc	np2
0	group	0.000	1.0	0.000	0.000	1.000000e+00	0.000
1	aoi	1.344	6.0	0.224	33.950	1.670173e-22	0.660
2	group * aoi	0.222	6.0	0.037	5.614	4.373096e-05	0.243
3	Residual	0.693	105.0	0.007	NaN	NaN	NaN

D Two-way ANOVA for time percentage for poster2

	Source	SS	DF	MS	F	p-unc	np2
0	group	0.000	1.0	0.000	0.000	1.000000e+00	0.000
1	aoi	1.069	6.0	0.178	13.442	2.926777e-11	0.434
2	group * aoi	0.284	6.0	0.047	3.569	2.944147e-03	0.169
3	Residual	1.391	105.0	0.013	NaN	NaN	NaN

F Two-way ANOVA for time percentage for poster3

	Source	SS	DF	MS	F	p-unc	np2
0	group	0.000	1.0	0.000	0.000	1.000000e+00	0.000
1	aoi	1.434	6.0	0.239	24.739	4.170981e-18	0.586
2	group * aoi	0.037	6.0	0.006	0.636	7.013739e-01	0.035
3	Residual	1.014	105.0	0.010	NaN	NaN	NaN

H Two-way ANOVA for time percentage for poster 4

	Source	SS	DF	MS	F	p-unc	np2
0	group	0.000	1.0	0.000	0.000	1.000000e+00	0.000
1	aoi	1.040	6.0	0.173	17.052	1.139206e-13	0.494
2	group * aoi	0.078	6.0	0.013	1.273	2.762264e-01	0.068
3	Residual	1.068	105.0	0.010	NaN	NaN	NaN

time.png

Figure 9: ANOVA analysis. A and B is the analysis of the percentage time for each segment for biological and computer science students on poster 1; C and D is the analysis of the percentage time for each segment for biological and computer science students on poster 2; E and F is the analysis of the percentage time for each segment for biological and computer science students on poster 3; G and H is the analysis of the percentage time for each segment for biological and computer science students on poster 4.

rate.png

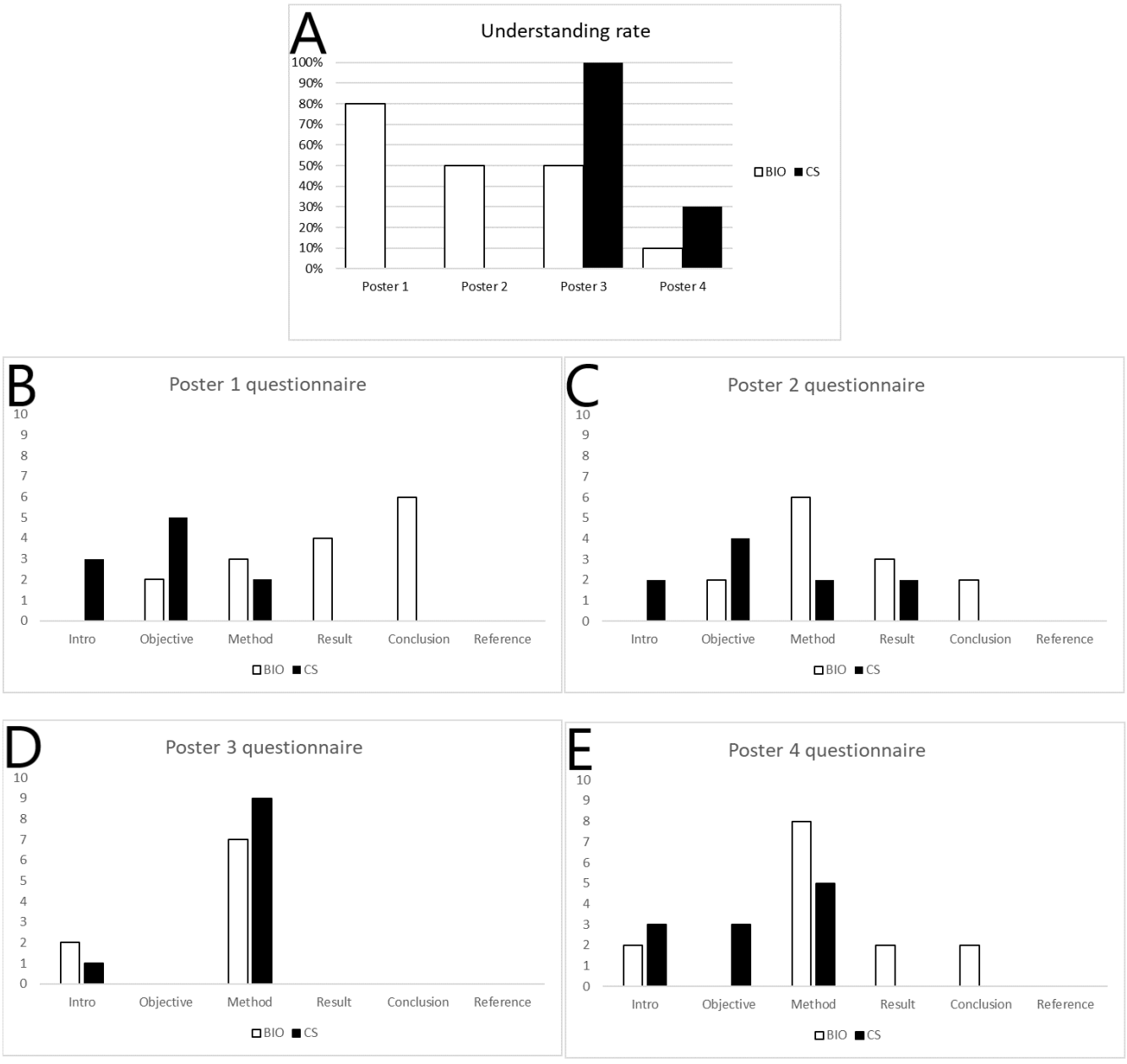


Figure 10: Understand rate and important parts. A is statistic result for understand rate. B, C, D, E is answer for which parts are most important for understanding contents for poster 1, 2, 3 and 4, accordingly

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